DISTRIBUTION OF *DROSOPHILA* SPECIES AND THEIR DIVERSITIES IN THE TROPICAL RAIN FORESTS OF WESTERN GHATS[1]

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(With a text-figure)

The studies on the Drosophilid fauna of the tropical rain forests of Western Ghats have revealed the occurrence of 40 species representing four genera namely *Drosophila, Scaptomyza, Phorticella* and *Leucophenga.* Majority of the species collected belong to the genus *Drosophila* while only three species belong to the latter three genera. The members of the genus *Drosophila* are shared by four subgenera namely *Sophophora, Drosophila, Scaptodrosophila* and *Dorsilopha,* of which the former two include the major bulk of 98.6% of the total population. The analysis of *Drosophila* fauna has revealed six new species namely *D. giriensis, D. jagri, D. sahyadrii, D. agumbensis, D. nagerholensis* and *D. gundensis;* and three new records namely *D. elegans, D. rhopaloa and D. grandis,* as well as several others which are not reported from plains of Peninsula indicating the diversity in the species composition.

The collection localities were found to vary a great deal in the composition and in the relative concentration of different species. Only two species namely *D. malerkotliana* and *D. nasuta* were found to be abundant at almost all the collection localities and can be adjudged as ecologically versatile. Another species *D. immigrans* which was not reported from the semiwild and domestic localities of Peninsular India was observed in large numbers in four of the eight localities indicating its preference to moist and humid climatic conditions. Similarly, *D. punjabiensis* which was occasionally reported from the semiwild localities was noticed in considerable numbers in three of the eight localities. Other species were found to be represented in low to moderate numbers.

The sympatric association and ecological dominance of the members belonging to *melanogaster* and *immigrans* species group of two different subgenera, *Sophophora* and *Drosophila* in the area under investigation, the wide spread and endemic characters of the *Drosophila* species and the finding of six new species as well as three new reports encountered in the collection are discussed.

Introduction

The Drosophilidae is a large family of flies of world-wide distribution. About half of the known species belong to the very large genus *Drosophila.* It is known to contain more than 1,300 biologically valid species (Bock and Parsons 1978). They have been categorised into nine subgenera namely, *Sophophora, Drosophila, Hirtodrosophila, Scaptodrosophila, Dorsilopha, Siphlodora, Sordophila, Phloridosa* and *Engiscaptomyza.* However, only the first four subgenera contain a substantial number of species which are generally regarded as representing major bursts in speciation. Parallel with the development of genetical and

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evolutionary knowledge, taxonomic studies in the genus have advanced a great deal in the past few decades. As a result of this, several new species are constantly being described and the total size of the genus must consist of at least 2,000 species (Stone *et al.* 1960).

The Indian sub-continent with its diverse climatic and varied physiographic conditions provides large number of natural environs for colonization by the members of the genus *Drosophila.* However, a vast area of great ecological interest still awaits exploration. Reference to literature reveals that very little information is available on several aspects of *Drosophila* biology. Inspite of the striking progress made during the last few years (Parshad and Paika 1964, Parshad and Duggal 1965, 1966; Rahman and Singh 1969, Gupta and Ray-Chaudhuri 1970a, b, c; Singh 1970, 1972; Jha, Mishra and Singh 1971, Reddy and Krishnamurthy 1971, 1974, 1977; Vaidya and Godbole 1971, 1972, 1973, 1976; Godbole and Vaidya 1972; Ranganath and Krishnamurthy 1972; Siddaveere Gowda and Krishnamurthy 1972; Gupta 1973, 1974; Siddaveere Gowda *et al.* 1977 and Gupta and Singh 1977), information pertaining to the occurrence and the pattern of distribution of Drosophilid fauna in various parts of the country is not clearly understood. Judging from the reports of *Drosophila* taxonomy from other parts of the world, it appears that the number of species reported thus far from the Indian subcontinent is too small and does not reflect the true picture of *Drosophila* fauna. Until recently almost nothing was known of *Drosophila* inhabiting the tropical rain forests of Western Ghats extending from river Tapti to Cape Comorin (Peninsular India). In view of this we have chose the unexplored areas of the tropical rain forests of Western Ghats to get an insight into the diversity in *Drosophila* species, their relative abundance and their dependance on the rain forest type of vegetation as well as their ecodistributional pattern of different species inhabiting this region.

Materials and Methods

Drosophila collections were made during the monsoon periods of 1976, 1977 and 1978 from eight localities of the tropical rain forests of Western Ghats (Fig. 1). The general ecogeographical features of the area under investigation as well as the topographical features and the climatic factors of eight localities are briefly described below.

Ecogeographical features of Western Ghats

Western Ghats extend along the western side of Peninsular India, from the mouth of the river Tapti to Cape Comorin. They include the humid belt of hilly or mountainous country. The vegetation of this part of the country is influenced more by the abundance and distribution of the seasonal rainfall than the atmospheric temperature. The western side of the Western Ghats is on the threshold of southwest monsoon and receives the maximum rainfall whereas, the eastern side lies in the rain-shadow area of the hills. The main types of soils met with in the Western Ghats are red, laterite, and black soils. Shifting cultivation, grazing and indiscriminate lopping have resulted in the destruction of some of the virgin forests, which now survive only in some of the inaccessible mountain summit areas. Introduction of plantation crops like tea, coffee, rubber and extension of teak in southern regions of Western Ghats and cultivation of *Eucalyptus* especially in Nilgiri have also resulted in the destruction of large virgin

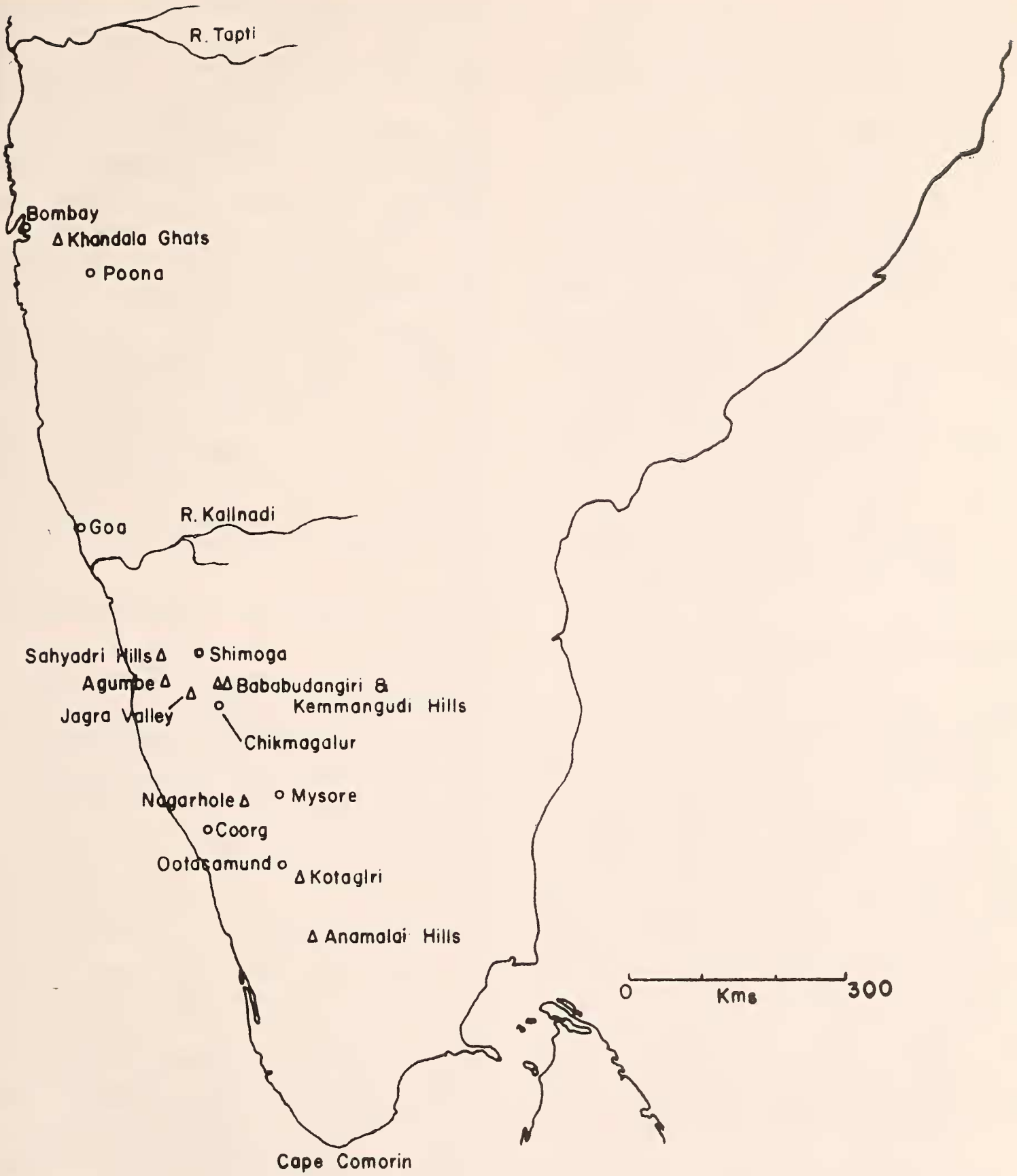

Fig. 1. Map of Peninsular India illustrating eight localities of Western Ghats from which *Drosophila* collections were made (△).

forests. Construction of large number of hydro-electric projects resulting in the submersion of catchment areas have further accelerated regressive changes in the forest flora of the region.

The most outstanding feature of Western Ghats is the development of the tropical rain forests prominently seen on the windward side of the southern part, usually between the altitudes of 500 to 1500 m. The humid tropic belt of Western Ghats possesses the following forest types : 1. tropical moist deciduous, 2. tropical semievergreen, and 3. tropical evergreen. According to Richards (1952) (cf. Subramanyam and Nayar 1974), tropical rain forests have no marked summer and winter seasons, but only wet and dry seasons. The seasonal changes of temperature are quite insignificant in relation to the seasonal variations in rainfall. The forests are characterised by multistoried canopies of vegetation and the various synusiae like : 1. trees and shrubs, 2. herbs, 3. climbers, 4. stranglers and 5. epiphytes. The ground layer and the trees themselves are carpeted with mosses, ferns, orchids and lichens and thus form a characteristic biological spectrum providing large number of natural environs for the colonization of the members of the genus *Drosophila.* Subramanyam and Nayar (1974) have divided the Western Ghats into four phytogeographical regions, namely : 1. the Western Ghats from the river Tapti to Goa, 2. the Western Ghats from the river Kalinadi to Coorg, 3. the Nilgiri and 4. the Anamalai, Palni and Cardamom Hills.

1. *Western Ghats from the river Tapti to Goa*

This botanical division is dominated by mountain chains, rising to 1000 m abruptly within a short distance of 2-3 km and is characterised by deep ravines, canyons and flat-topped spurs intersected by valleys. It receives the full blast of the monsoon rainfall from June to September. The vegetation consists of dry deciduous, moist deciduous and evergreen forests, However, Qureshi (1965) remarks that the evergreen forests occurring in this region are not typical tropical evergreen forests. Hence they are classified as montane subtropical evergreen forests. *Drosophila* collection was made at one locality namely Khandala Ghats.

Khandala Ghats are located between Poona and Bombay, situated at 19° 0 'N latitude and 73° 10'E longitude. The temperature ranges from 14°C to 30°C, with a relative humidity of 65% to 80%. The average annual rainfall is about 3,950 mm. Collections were made at various altitudes of 760-790 m.

2. *Western Ghats from the river Kalinadi to Coorg*

This region is marked by a series of breaches in the mountain wall by the rivers Kalinadi, Gangavali Bedti, Tadri and Sharavati. The access to the interior is not easy, since the valleys are surrounded by deep gorges 3-5 km across and 300 m deep. The entire area is hot and humid. The heavy rainfall favours thick tropical forest growth with best teak plantations in the upper evergreen zone. The main types of vegetation observed here are scrub, moist deciduous and evergreen forests. Five localities namely Sahyadri Hills' range, Agumbe, Jagra Valley, Bababudangiri and Kemmangundi Hills' range and Nagarhole were chosen to analyse the *Drosophila* fauna. The brief description of these localities are as follows :

i) *Sahyadri Hills' range* extends towards the western side of Shimoga and situated at 13° 45'N latitude and 74° 48'E longitude. It has an average annual rainfall of about

2,978 mm. The temperature ranges from 18°C to 32°C, with a relative humidity of 60% to 81%. The altitudes of the collection sites range from 590 to 710 m.

ii) *Agumbe* is located to the southwest of Shimoga and situated at 13° 18'N latitude and 74° 38' E longitude. It receives very heavy rainfall with an annual average of 8,275 mm. Because of the heavy rainfall it is called *'Cheera Punji'* of South India. This has contributed to the growth of dense forest in the locality. The temperature ranges from 17°C to 31°C with a relative humidity of 70% to 90%. The altitudes of the collection sites range from 760 to 800 m.

iii) *Jagra Valley* is situated at a distance of 50 km to the west of Chikmagalur and located at 13° 10'N latitude and 75° 45'E longitude. It has an average annual rainfall of about 2,160 mm. The temperature ranges from 16°C to 30°C, with a relative humidity of 75% to 90%. Collections were made at various altitudes of 700-780 m.

iv) *Bababudangiri and Kemmangundi Hills' range* is a picturesque place of Western Ghats situated at 13° 17'E latitude and 75° 45'E longitude. The average annual rainfall is about 2,856 mm. The temperature ranges from 12°C to 32°C, with a relative humidity of 76% to 93%. The altitudes of the collection sites range from 1000 to 1600 m. Many of the hills are covered with heavy forests, while valleys and ravines produce luxuriant trees known for their great height and size.

v) *Nagarhole* is about 75 km to the west of Mysore City and situated at 12° 18'N latitude and 70° 09'E longitude. It has an average annual rainfall of 1,610 mm. The temperature ranges from 18°C to 30°C with a relative humidity of 55% to 80%. The altitudes of the collection sites range from 760 to 790 m.

3. *The Nilgiri Hills*

Nilgiri forms a compact plateau with the highest elevation of 2,670 m at Doddabetta and dissected much-worn massif, with steep hills and rolling downs, interspersed with *shola* forests. The forest is evergreen, composed of tropical and sub-tropical vegetation. The *sholas* are characteristically filled with evergreen forests with thick undergrowth. *Drosophila* collection was made at one locality namely Kotagiri.

Kotagiri is about 25 km to the southeast of Ootacamund and situated at 11° 22'N latitude and 77° 05'E longitude. The average annual rainfall is about 1,524 mm. The temperature ranges from 12°C to 30°C, with a relative humidity of 70% to 85%. The altitudes of the collection sites range from 1400 to 1960 m.

4. *The Anamalai, Cardamom and Palni Hills*

The topography of this region is remarkably more complex than the Nilgiris. They have the highest peak of 2,695 m in the Peninsula. In the northwest, the hills fray out into long southeast-northwest ridges. The types of vegetation on these hills are dry deciduous type at the lower elevations with an annual rainfall ranging from 1600-2600 mm; and moist deciduous type between the altitudes of 500-900 m with a rainfall from 2400-3500 mm. The wet evergreen forest types are also seen on elevations ranging from 500-2500 m along the windward side of the Western Ghats, where the rainfall ranges from 2500 to 5000 mm. *Drosophila* collections were made at one locality namely Anamalai Hills.

Anamalai Hill range is situated at 10° 24'N latitude and 76° 40°E longitude. The

average annual rainfall is about 4,000 mm. The temperature ranges from 12°C to 30°C, with a relative humidity of 80% to 90%. The altitudes of the collection sites range from 800 to 2,400 m. The collections were made mostly in moist deciduous type and wet evergreen forests.

Collection methods

Drosophila collections were made at five sites in each of the eight localities except for Bababudangiri and Kemmangundi Hills' range where 12 sites were selected. The sites chosen are 5-10 km apart and have at least one element in common and that is shade from the direct sun rays. Collections were carried out by using 10 traps (250 ml milk bottles) at each site, enabling the comparison of quantitative differences among the sites to be made. The conventional bait such as fermenting banana fruit, a technique successful for most Indian species of the subgenera *Sophophora* and *Drosophila,* but less so for species of the other subgenera was employed. Occasionally, sweeping off foliage and leaf litter was made, which was found to be successful for the members of the subgenera *Scaptodrosophila* and *Drosophila.*

Bottles containing bait were tied up to the branches of trees and bushes in the vicinity of permanent water or moisture. Away from moist area, especially in dry weather, the yield of flies was consistently low. Members of the genus *Drosophila* have been shown to be very sensitive to desiccation and high temperature stresses (Parsons 1977), so that on sunny days flies are usually found in cool, damp shaded microniches. Bottles were collected after two days during cooler hours of the day. The collected flies were sorted out, categorized and number of each species was recorded. The individual females which could not be assigned to any taxonomic group were isolated and allowed to breed in separate vials with a standard *Drosophila* food medium. The progenies of such gravid females were used for detailed studies to assign them to their respective groups.

Observations

The occurrence, distributional pattern and the relative abundance of the species collected in each of the eight localities of four phytogeographical regions of Western Ghats are presented below :

1. *Western Ghats from the river Tapti to Goa*

Khandala Ghats : A survey of *Drosophila* fauna of this locality yielded a total of 2,660 flies comprising of 11 species representing four subgenera, *Sophophora, Drosophila, Scaptodrosophila* and *Dorsilopha* of the genus *Drosophila.* The number of individuals of different species collected at five sites along with their respective altitudes are given in table 1. Of the 11 species collected, *D. malerkotliana* and *D. punjabiensis* were found to dominate the collections with a total of 777 (29.2%) and 698 (26.2%) flies respectively. *D. jambulina* and *D. nasuta* were next to them with 342 (12.9%) and 301 (11.3%) flies respectively. Two other species, *D. bipectinata* and *D. rajasekari* with 177 (6.7%) and 122 (4.2%) individuals respectively were found in moderate numbers in the collections. The above six species were noticed in almost all the sites scanned. While other species such as *D. takahashii, D. neonasuta, D. brindavani, D. krishnamurthyi* and *D. busckii* were less common and comprise only about 9.5% of the total flies collected.

TABLE 1

DISTRIBUTION OF DIFFERENT SPECIES OF *Drosophila* IN KHANDALA GHATS (WESTERN GHATS)

Collection Site	I	II	III	IV	V	Total
Altitude (in metres)	760	760	770	780	790	
Subgenus: *Sophophora*						
D. takahashii	11	31	—	11	35	88
D. rajasekari	5	9	58	30	10	112
D. malerkotliana	254	157	206	102	58	777
D. bipectinata	73	38	—	46	20	177
D. punjabiensis	67	71	58	243	259	698
D. jambulina	37	14	120	82	89	342
Subgenus: *Drosophila*						
D. nasuta	38	68	41	80	74	301
D. neonasuta	—	20	—	33	9	62
D. brindavani	—	—	16	—	11	27
Subgenus: *Scaptodrosophila*						
D. krishnamurthyi	14	13	8	10	21	66
Subgenus: *Dorsilopha*						
D. busckii	—	3	1	6	—	10
Total	499	424	508	643	586	2660
Number of species	8	10	8	10	10	

2. *Western Ghats from the river Kalinadi to Coorg*

i) *Sahyadri Hills' range* : The population sample of this locality yielded a total of 1,531 flies comprising 10 species representing two subgenera, *Sophophora* and *Drosophila* of the genus *Drosophila.* The distributional pattern and the relative numbers of the species collected along with the altitudes of the collection sites are shown in table 2. The number of individuals of different species vary a great deal from one site to another. Of the 10 species collected, only two namely *D. malerkotliana* and *D. nasuta* with 678 (44.3%) and 433 (28.3%) flies respectively were found to dominate in all the sites forming more than 2/3 of the total flies trapped. Two other species, *D. anomelani* and *D. bipectinata* were also observed in almost all the sites with moderate frequencies of 109 (7.1%) and 88 (5.7%) individuals respectively. The remaining six species namely *D.takahashii, D. eugracilis, D. sahyadrii* sp. nov., *D. mysorensis, D. agumbensis* sp. nov. and *D. neonasuta* were less common and contribute only about 14.6% to the total population. A noteworthy feature of this locality is that there is a gradual transition of scrub type of vegetation to evergreen flora in east-west direction making the sites increasingly favourable for the colonization of *Drosophila.* This is reflected by the increase in the variety and the relative numbers of different species collected in east-west direction (table 2).

ii) *Agumbe* : The population sample of this locality is comparatively small, with a total of 1,170 individuals consisting of 12 species representing three subgenera, *Sophophora, Drosophila* and *Scaptodrosophila* of the

TABLE 2

DISTRIBUTION OF DIFFERENT SPECIES OF *Drosophila* IN SAHYADRI HILLS' RANGE (WESTERN GHATS)

Collection Site	I	II	III	IV	V	Total
Altitude (in metres)	590	620	650	690	710	
Subgenus: *Sophophora*						
D. takahashii	—	9	7	11	—	27
D. eugracilis	4	14	22	—	22	62
D. sahyadrii sp. nov.	6	—	—	—	3	9
D. malerkotliana	49	45	194	160	230	678
D. bipectinata	—	20	10	26	32	88
D. anomelani	11	24	24	19	31	109
D. mysorensis	—	6	1	21	12	40
D. agumbensis sp. nov.	25	—	12	2	18	57
Subgenus: *Drosophila*						
D. nasuta	47	60	58	86	182	433
D. neonasuta	1	—	—	3	24	28
Total	143	178	328	328	554	1531
Number of species	7	7	8	8	9	

TABLE 3

DISTRIBUTION OF DIFFERENT SPECIES OF *Drosophila* IN AGUMBE (WESTERN GHATS)

Collection Site	I	II	III	IV	V	Total
Altitude (in metres)	760	770	785	790	800	
Subgenus: *Sophophora*						
D. eugracilis	12	26	4	17	21	80
D. pseudoananassae	11	8	—	—	9	28
D. malerkotliana	105	85	53	27	69	339
D bipectinata	21	18	—	15	28	82
D. anomelani	13	41	29	22	35	140
D. montium	22	13	18	3	—	56
D. rhopaloa	3	21	—	4	15	43
D. agumbensis sp. nov.	15	—	8	10	—	33
Subgenus: *Drosophila*						
D. nasuta	57	48	33	65	75	278
D. neonasuta	16	14	9	11	18	68
D. grandis	—	—	—	—	2	2
Subgenus: *Scaptodrosophila*						
D. mundagenesis	4	1	8	3	5	21
Total	279	275	162	177	277	1170
Number of species	11	10	8	10	10	

genus *Drosophila.* The collection data along with the altitudes of the sites are shown in table 3. The low yield of flies from this locality was due to the disturbance caused by the heavy rainfall at the time of collection. Of the 12 species, only three, namely *D. malerkotliana* with 339 (29%), *D. nasuta* with 278 (23.8%) and *D. anomelani* with 140 (12%) individuals were found to dominate in all the sites scanned. The remaining nine species namely *D. eugracilis, D. pseudoananassae, D. bipectinata, D. agumbensis* sp. nov., *D. montium, D. rhopaloa, D. neonasuta, D. grandis* and *D. mundagenesis* were found in moderate frequencies and form the rest of the population sampled.

iii) *Jagra Valley* : Analysis of the *Drosophila* sample of 1,537 flies from this locality revealed the occurrence of 13 species representing only two subgenera, *Sophophora* and *Drosophila* of the genus *Drosophila.* The number of individuals of each species collected and the altitudes of the collection sites are shown in table 4. Nine of the 13 species observed, belong to the subgenus *Sophophora* and four to the subgenus *Drosophila.* Five species namely *D. malerkotliana* (289 or 18.8%), *D. immigrans* (232 or 15.1%), *D. anomelani* (220 or 14.4%), *D. mysorensis* (200 or 13%) and *D. nasuta* (184 or 12%) were found to be present in all the sites forming the major bulk of the total population with 73.3%. While the remaining species such as *D. jagri* sp. nov., *D. eugracilis, D. bipectinata, D. jambulina, D. gundensis* sp. nov., *D. neonasuta* and D. *nigra* were observed in moderate numbers in some sites contributing to the rest of the collection.

iv) *Bababudangiri and Kemmangundi Hills' range* : Analysis of the population sample

TABLE 4

DISTRIBUTION OF DIFFERENT SPECIES OF *Drosophila* IN JAGRA VALLEY (WESTERN GHATS)

Collection Site	I	II	III	IV	V	Total
Altitude (in metres)	720	745	755	765	780	
Subgenus: *Sophophora*						
D. takahashii	—	22	24	3	10	59
D. jagri sp. nov.	16	11	—	—	19	46
D. eugracilis	—	27	—	24	19	70
D. malekotliana	49	29	57	77	77	289
D. bipectinata	20	—	35	3	14	72
D. jambulina	4	—	20	7	—	31
D. anomelani	44	46	39	47	44	220
D. mysorensis	65	29	35	37	34	200
D. gundensis sp. nov.	13	—	4	—	9	26
Subgenus: *Drosophila*						
D. neonasuta	44	38	46	49	7	184
D. neonasuta	20	26	—	18	38	102
D. immigrans	54	39	33	65	41	232
D. nigra	—	1	5	—	—	6
Total	329	268	298	330	312	1537
Number of species	10	10	10	10	11	

TABLE 5

DISTRIBUTION OF DIFFERENT SPECIES OF DROSOPHILIDAE IN BABABUDANGIRI AND KEMMANGUNDI HILLS' RANGE (WESTERN GHATS)

Collection Site	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
Altitude (in metres)	1000	1050	1250	1250	1250	1300	1325	1350	1375	1375	1500	1600	
Genus: *Drosophila*													
Subgenus: *Sophophora*													
D. takahashii	24	—	—	39	—	—	—	—	—	—	—	—	63
D. giriensis sp. nov.	18	—	45	—	18	—	—	13	50	13	—	—	157
D. suzukii	—	—	—	—	—	—	1	—	—	—	—	—	1
D. eugracilis	36	—	—	26	—	—	—	—	48	—	—	—	110
D. ananassae	—	—	—	—	—	—	—	8	—	—	—	—	8
D. bipectinata	—	—	—	—	9	—	22	—	17	—	—	—	48
D. malerkotliana	26	—	—	32	29	15	19	—	50	49	—	—	220
D. punjabiensis	—	—	17	—	—	—	—	—	8	—	—	—	25
D. jambulina	9	—	—	—	—	3	—	6	—	—	—	—	18
D. mysorensis	18	35	53	24	19	27	29	20	67	38	30	23	383
D. anomelani	21	25	—	—	—	—	—	—	—	—	—	—	46
D. rhopaloa	—	18	—	28	24	20	—	18	48	20	—	—	176
D. gundensis sp. nov.	—	—	—	—	—	4	—	—	—	4	—	—	8
Species 'U'*	—	—	—	—	—	—	—	—	—	—	—	1	1
Subgenus: *Drosophila*													
D. nasuta	65	38	68	26	46	10	44	29	72	20	38	30	486
D. neonasuta	—	—	—	—	4	—	—	—	8	—	—	—	12
D. immigrans	23	44	—	37	43	79	81	47	54	29	115	29	581
D. brindavani	—	—	—	—	—	—	6	—	—	—	—	—	6
Species 'N'*	—	—	—	—	—	—	—	—	—	11	—	—	11
Subgenus: *Scaptodrosophila*													
D. meijerei indicus	—	—	—	—	—	—	—	—	—	1	—	—	1
D. mundagenesis	37	16	—	—	—	—	—	—	—	—	—	—	53
Genus: *Scaptomyza*													
Scaptomyza elmoi	—	—	—	—	—	—	1	—	—	—	—	—	1
Total	277	176	183	212	192	158	203	141	422	185	183	83	2415
Number of species	10	6	4	7	8	7	8	7	10	9	3	4	

* Unidentified members of the genus ***Drosophila.***

TABLE 6

DISTRIBUTION OF DIFFERENT SPECIES OF *Drosophila* IN NAGARHOLE (WESTERN GHATS)

Collection Site	I	II	III	IV	V	Total
Altitude (in metres)	760	765	780	790	790	
Subgenus: *Sophophora*						
D. takahashii	—	5	24	16	12	57
D. eugracilis	—	1	30	5	18	54
D. bipectinata	4	—	3	34	26	67
D. malerkotliana	62	61	81	118	227	549
D. punjabiensis	12	5	18	14	16	65
D. jambulina	5	19	34	32	35	125
D. kikkawai	—	—	19	7	14	40
D. anomelani	5	—	22	—	14	41
D. mysorensis	—	—	18	12	9	39
D. nagarholensis sp. nov.	1	—	7	3	5	16
Subgenus: *Drosophila*						
D. nasuta	19	36	91	56	95	297
D. neonasuta	—	42	50	69	42	203
D. repleta	—	—	4	1	3	8
Subgenus: *Scaptodrosophila*						
D. mundagenesis	—	—	5	1	1	7
D. meijerei indicus	—	1	1	1	5	8
Total	108	170	407	369	522	1576
Number of species	7	8	15	14	15	

of this locality yielded a total of 2,415 flies comprising 22 species, of which 21 belong to three subgenera, *Sophophora, Drosophila* and *Scaptodrosophila* of the genus *Drosophila* and one to the genus *Scaptomyza.* The occurrence, distributional pattern and the relative numbers of each of the species collected at 12 sites along with the respective altitudes of the sites are shown in table 5. Among the *Drosophila* species collected only four, namely *D. immigrans* (581 or 24.1%), *D. nasuta* (486 or 20.1%), *D. mysorensis* (383 or 15.9%) and *D. malerkotliana* (220 or 9.1%) were found to dominate the population of this locality forming nearly 70%. While three other species namely *D. rhopaloa* (176 or 7.3%), *D. giriensis* sp. nov. (157 or 6.5%) and *D. eugracilis* (110 or 4.6%) were observed in moderate numbers at some sites, and together contribute 18.4% to the total. The remaining 14 species of the genus *Drosophila* namely *D. takahashii, D. suzukii, D. ananassae, D. bipectinata, D. punjabiensis, D. jambulina, D. anomelani, D. gundensis* sp. nov., *D. neonasuta, D. brindavani, D. meijerei indicus, D. mundagensis,* species *'U'* and species *'N'* (unidentified members of the genus *Drosophila*) were found to occur in very low frequencies at some sites, forming only 12.4% of the total population. *Scaptomyza elmoi,* a member of the genus *Scaptomyza* was represented by only one individual in the collection. Considerable variation in the species composition and the number of individuals of different species was observed at different sites.

v) *Nagarhole* : *Drosophila* sample analysed from this locality revealed a total of 1,576 flies comprising 15 species representing three subgenera, *Sophophora, Drosophila* and *Scaptodrosophila* of the genus *Drosophila.* Collection data along with the respective altitudes of the sites are shown in table 6. Only four species namely *D. malerkotliana* (549 or 34.8%), *D. nasuta* (297 or 18.9%), *D. neonasuta* (203 or 12.9%) and *D. jambulina* (125 or 7.9%) form the major bulk with 74.5% of the total population. The remaining species namely *D. takahashii, D. eugracilis, D. bipectinata, D. punjabiensis, D. kikkawai, D. mysorensis, D. anomelani, D. nagaraholensis* sp. nov., *D. repleta, D. mundagensis* and *D. meijerei indicus* were found in comparatively low frequencies and comprise only about 25.5% of the total population. Considerable variation in the species composition and the number of individuals was noticed among the sites scanned in this locality.

3. *The Nilgiri Hills*

Kotagiri: *Drosophila* survey of this locality yielded a total of 1,505 flies comprising 11 species representing two genera, *Drosophila* and *Phorticella.* The occurrence and the relative frequencies of the species collected along with the respective altitudes of the sites are shown in table 7. The collection record reveals considerable uniformity in the species composition and the number of individuals among the five sites. Only three species, namely *D. immigrans* (598 or 39.7%), *D. malerkotliana* (395 or 26.2%) and *D. nasuta* (198 or 13.2%) were found to dominate with 79.1%. The other two species, *D. kikkawai* (93 or 6.1%) and *D. mysorensis* (82 or 5.5%) were found in all the sites. The remaining five species, *D. takahashii, D. elegans. D. anan-*

TABLE 7

DISTRIBUTION OF DIFFERENT SPECIES OF DROSOPHILIDAE IN KOTAGIRI (WESTERN GHATS)

Collection Site	I	II	III	IV	V	Total
Altitude (in metres)	1400	1660	1725	1830	1960	
Genus: *Drosophila*						
Subgenus: *Sophophora*						
D. takahashii	—	13	28	6	9	56
D. elegans	12	1	7	—	—	20
D. ananassae	9	—	—	7	3	19
D. malerkotliana	104	78	64	53	96	395
D. mysorensis	13	9	18	29	13	82
D. kikkawai	18	25	11	31	8	93
D. seguyi	5	—	—	11	7	23
Subgenus: *Drosophila*						
D. nasuta	32	23	56	39	48	198
D. immigrans	85	93	121	146	153	598
D. nigra	3	—	—	8	5	16
Genus: *Phorticella*						
Phorticella flavipennis	—	2	—	—	3	5
Total	281	244	305	330	345	1505
Number of species	9	8	7	9	10	

assae, D. seguyi and *D. nigra* were found in moderate numbers at some sites and absent from others. Only five individuals of *P. flavipennis* were observed in two, of the five sites scanned.

4. *The Anamalai, Palni and Cardamom Hills*

Anamalai Hills' range : A total of 1,461 flies examined from this locality was found to comprise 12 species representing two genera, *Drosophila* and *Leucophenga.* The distributional pattern and the numbers of each species against the collection sites along with the respective altitudes are shown in table 8. Of the 12 species, only three namely *D. immigrans* (605 or 41.5%), *D. malerkotliana* (435 or 29.8%) and *D. nasuta* (156 or 10.7%) were found to dominate the collection with 81.9% While the remaining eight species of the genus *Drosophila* namely *D. takahashii, D. suzukii, D. eugracilis, D. kikkawai, D. rufa, D. rhopaloa, D. repleta* and *D. busckii* were found in low frequencies and represent only 18% of the total population. Only two individuals of *L. interrupta* were observed in one site, representing the genus *Leucophenga.*

The Drosophilid survey of the tropical rain forests of Western Ghats in the aforementioned localities yielded a total of 13,855 flies comprising 40 species representing four genera namely *Drosophila, Scaptomyza, Phorticella* and *Leucophenga.* Majority of the species collected belong to the genus *Drosophila,* while only three species belong to the latter three genera. Further, the members belonging

TABLE 8

DISTRIBUTION OF DIFFERENT SPECIES OF DROSOPHILIDAE IN ANAMALAI HILLS' RANGE (WESTERN GHATS)

Collection Site	I	II	III	IV	V	Total
Altitude (in metres)	800	1360	1640	2100	2400	
Genus: *Drosophila*						
Subgenus: *Sophophora*						
D. takahashii	—	9	15	18	7	49
D. suzukii	4	—	—	—	—	4
D. eugracilis	18	—	—	23	22	63
D. malerkotliana	65	48	93	101	128	435
D. kikkawai	13	19	11	7	—	50
D. rufa	—	13	9	21	8	51
D. rhopaloa	8	10	16	4	—	38
Subgenus: *Drosophila*						
D. nasuta	23	23	18	41	51	156
D. immigrans	88	131	125	78	183	605
D. repleta	—	1	2	3	—	6
Subgenus: *Dorsilopha*						
D. busckii	—	—	—	—	2	2
Genus: *Leucophenga*						
Leucophenga interrupta	—	—	2	—	—	2
Total	219	254	291	296	401	1461
Number of species	7	8	9	9	7	

TABLE 9

RELATIVE ABUNDANCE OF DROSOPHILIDS IN EIGHT LOCALITIES OF WESTERN GHATS

Localities	Khandala Ghats	Sahyadri Hills' range	Agumbe	Jagra Valley	Bababudangiri & Kemmangundi Hills' range	Nagarhole	Kotagiri	Anamalai Hills' range	Total
Species									
D. takahashii	88	27	—	59	63	57	56	49	399
*D. giriensis**	—	—	—	—	157	—	—	—	157
*D. jagri**	—	—	—	46	—	—	—	—	46
D. suzukii	—	—	—	—	1	—	—	4	5
D. rajasekari	112	—	—	—	—	—	—	—	112
*D. sahyadrii**	—	9	—	—	—	—	—	—	9
*D. elegans***	—	—	—	—	—	—	20	—	20
D. eugracilis	—	62	80	70	110	54	—	63	439
D. ananassae	—	—	—	—	8	—	19	—	27
D. pseudoananassae	—	—	28	—	—	—	—	—	28
D. malerkotliana	777	678	339	289	220	549	395	435	3682
D. bipectinata	177	88	82	72	48	67	—	—	534
D. punjabiensis	698	—	—	—	25	65	—	—	788
D. jambulina	342	—	—	31	18	125	—	—	516
D. anomelani	—	109	140	220	46	41	—	—	556
D. mysorensis	—	40	—	200	383	39	82	—	744
D. kikkawai	—	—	—	—	—	40	93	50	183
D. montium	—	—	56	—	—	—	—	—	56
D. rufa	—	—	—	—	—	—	—	51	51
D. seguyi	—	—	—	—	—	—	23	—	23
*D. rhopaloa***	—	—	43	—	176	—	—	38	257
*D. gundensis**	—	—	—	26	8	—	—	—	34

TABLE 9 (Contd.)

Localities	Khandala Ghats	Sahyadri Hills' range	Agumbe	Jagra Valley	Bababudangiri & Kemmangundi Hills' range	Nagarhole	Kotagiri	Anamalai Hills' range	Total
Species									
*D. agumbensis**	—	57	33	—	—	—	—	—	90
*D. nagarholensis**	—	—	—	—	—	16	—	—	16
Species *'U'***	—	—	—	—	1	—	—	—	1
Species *'N'***	—	—	—	—	11	—	—	—	11
D. nasuta	301	433	278	184	486	297	198	156	2333
D. neonasuta	62	28	68	102	12	203	—	—	475
D. immigrans	—	—	—	232	581	—	598	605	2016
D. brindavani	27	—	—	—	6	—	—	—	33
D. repleta	—	—	—	—	—	8	—	6	14
D. nigra	—	—	—	6	—	—	16	—	22
*D. grandis***	—	—	2	—	—	—	—	—	2
D. meijerei indicus	—	—	—	—	1	8	—	—	9
D. mundagenesis	—	—	21	—	53	7	—	—	81
D. krishnamurthyi	66	—	—	—	—	—	—	—	66
D. busckii	10	—	—	—	—	—	—	2	12
*Scaptomyza elmoi***	—	—	—	—	1	—	—	—	1
Leucophenga interrupta	—	—	—	—	—	—	—	2	2
*Phorticella flavipennis***	—	—	—	—	—	—	5	—	5
Total	2660	1531	1170	1537	2415	1576	1505	1461	13855
Number of species	11	10	12	13	22	15	11	12	

* New species; ** New reports; *** Unidentified species.

TABLE 9

RELATIVE ABUNDANCE OF DROSOPHILIDS IN EIGHT LOCALITIES OF WESTERN GHATS

Localities	Khandala Ghats	Sahyadri Hills' range	Agumbe	Jagra Valley	Bababudangiri & Kemmangundi Hills' range	Nagarhole	Kotagiri	Anamalai Hills' range	Total
Species									
D. takahashii	88	27	—	59	63	57	56	49	399
*D. giricusis**	—	—	—	—	157	—	—	—	157
*D. jagri**	—	—	—	46	—	—	—	—	46
D. suzukii	—	—	—	—	1	—	—	4	5
D. rajasekari	112	—	—	—	—	—	—	—	112
*D. sahyadrii**	—	9	—	—	—	—	—	—	9
*D. elegans***	—	—	—	—	—	—	20	—	20
D. engracilis	—	62	80	70	110	54	—	63	439
D. ananassae	—	—	—	—	8	—	19	—	27
D. pseudoananassae	—	—	28	—	—	—	—	—	28
D. malerkotliana	777	678	339	289	220	549	395	435	3682
D. bipectinata	177	88	82	72	48	67	—	—	534
D. punjabiensis	698	—	—	—	25	65	—	—	788
D. jambulina	342	—	—	31	18	125	—	—	516
D. auromelani	—	109	140	220	46	41	—	—	556
D. mysorensis	—	40	—	200	383	39	82	—	744
D. kikkawai	—	—	—	—	—	40	93	50	183
D. montium	—	—	56	—	—	—	—	—	56
D. rufa	—	—	—	—	—	—	—	51	51
D. seguyi	—	—	—	—	—	—	23	—	23
*D. rhopaloa***	—	—	43	—	176	—	—	38	257
*D. gundensis**	—	—	—	26	8	—	—	—	34

TABLE 9 (Contd.)

Localities	Khandala Ghats	Sahyadri Hills' range	Agumbe	Jagra Valley	Bababudangiri & Kemmangundi Hills' range	Nagarhole	Kotagiri	Anamalai Hills' range	Total
Species									
*D. agumbensis**	—	57	33	—	—	—	—	—	90
*D. nagarholensis**	—	—	—	—	—	16	—	—	16
Species 'U'***	—	—	—	—	1	—	—	—	1
Species 'N'***	—	—	—	—	11	—	—	—	11
D. nasuta	301	433	278	184	486	297	198	156	2333
D. neonasuta	62	28	68	102	12	203	—	—	475
D. immigrans	—	—	—	232	581	—	598	605	2016
D. brindavani	27	—	—	—	6	—	—	—	33
D. repleta	—	—	—	—	—	8	—	6	14
D. nigra	—	—	—	6	—	—	16	—	22
*D. graudis***	—	—	2	—	—	—	—	—	2
D. meijerei indicus	—	—	—	—	1	8	—	—	9
D. mundagenesis	—	—	21	—	53	7	—	—	81
D. krishnamurthyi	66	—	—	—	—	—	—	—	66
D. buscki	10	—	—	—	—	—	—	2	12
*Scaptomyza elmoi***	—	—	—	—	1	—	—	—	1
Leucophenga interrupta	—	—	—	—	—	—	—	2	2
*Phortica flavipennis***	—	—	—	—	—	—	5	—	5
Total	2660	1531	1170	1537	2415	1576	1505	1461	13855
Number of species	11	10	12	13	22	15	11	12	

* New species; ** New reports; *** Unidentified species.

to genus *Drosophila* are represented by four subgenera namely *Sophophora, Drosophila, Scaptodrosophila* and *Dorsilopha,* of which the former two comprise the major bulk with 98.6% of the total population. The species composition and the relative abundance of different species in the localities under investigation are summarised in table 9. The localities were found to differ a great deal in the composition of the *Drosophila* species, inspite of the similarities of the habitats in the environmental factors such as temperature, humidity, rainfall, vegetation, availability of food, etc. Similarly, the variations in the number of individuals of different species was a common feature among the sites of any one locality (tables 1-8). Perusal of table 9 reveals that only 11 species namely *D. malerkotliana, D. nasuta, D. takahashii, D. eugracilis, D. bipectinata, D. neonasuta, D. anomelani, D. mysorensis, D. immigrans, D. jambulina* and *D. punjabiensis* were found to occur in considerable numbers. Of these only two species *D. malerkotliana* and *D. nasuta* were observed in large numbers in almost all the localities. In addition, *D. immigrans* was found to be another abundant species in four of the eight localities. These three species contribute nearly 58.2% to the total *Drosophila* sample analysed. The remaining eight species contribute 32.2% to the total population. Thus the above mentioned 11 species together comprise 90.4% of the total flies collected in the area. while the remaining species of the *Drosophila* sample were represented by only a few individuals.

The occurrence and the distributional pattern of Drosophilid species collected in the present study is shown in table 10. The pattern of distribution of different species was found to vary a great deal. The abundant species mentioned above, except *D. punjabiensis,* were found to be present in more than four localities, while the others were observed in less than four localities. Only two species *D. malerkotliana* and *D. nasuta* were noticed in all the localities. But *D. takahashii* was observed in seven, *D. eugracilis, D. bipectinata* and *D. neonasuta* in six, *D. anomelani* and *D. mysorensis* in five, *D. jambulina* and *D. immigrans* in four localities. Thus these species which were observed in more than four localities have been considered as more or less widely distributed. The remaining species which were observed in less than four localities have been treated as sparsely distributed.

Among the Drosophilids collected in the present study, six species namely *D. giriensis, D. jagri, D. sahyadrii, D. agumbensis, D. nagaraholensis* and *D. gundensis* are new. In addition, three species *D. elegans, D. rhopaloa* and *D. grandis* of the genus *Drosophila,* one species *S. elmoi,* a member of the genus *Scaptomyza,* and another *P. flavipennis,* a member of the genus *Phorticella* have been collected for the first time from India. The relative numbers and distributional pattern of these species are shown in table 9 and 10.

Discussion

The study of evolution in any group of animals or plants implies a knowledge of the number and distribution of the species involved and the population structure and habits of the species in relation to their environment (Heed 1957). Genus *Drosophila* with its cosmopolitan nature and complexities in species composition provides an excellent material to understand the ecodistributional pattern of various species. Systematic study concerning the variations in species composition and the distributional pattern of the mem-

TABLE 10

DISTRIBUTION OF DROSOPHILIDS IN EIGHT LOCALITIES OF WESTERN GHATS

Localities / Species	Khandala Ghats	Sahyadri Hills' range	Agumbe	Jagra Valley	Bababudangiri & Kemmangundi Hills' range	Nagarhole	Kotagiri	Anamalai Hills' range
Genus: *Drosophila*								
D. takahashii	+	+	–	+	+	+	+	+
*D. giriensis**	–	–	–	–	+	–	–	–
*D. jagri**	–	–	–	+	–	–	–	–
D. suzuki	–	–	–	–	+	–	–	+
D. rajasekari	+	–	–	–	–	–	–	–
*D. sahyadrii**	–	+	–	–	–	–	–	–
*D. elegans***	–	–	–	–	–	–	+	–
D. eugracilis	–	+	+	+	+	+	–	+
D. ananassae	–	–	–	–	+	–	+	–
D. pseudoananassae	–	–	+	–	–	–	–	–
D. malerkotliana	+	+	+	+	+	+	+	+
D. bipectinata	+	+	+	+	+	+	–	–
D. punjabiensis	+	–	–	–	+	+	–	–
D. jambulina	+	–	–	+	+	+	–	–
D. anomelani	–	+	+	+	+	+	–	–
D. mysorensis	–	+	–	+	+	+	+	–
D. kikkawai	–	–	–	–	–	+	+	+
D. montium	–	–	+	–	–	–	–	–
D. rufa	–	–	–	–	–	–	–	+
D. seguyi	–	–	–	–	–	–	+	–
*D. rhopaloa***	–	–	+	–	+	–	–	+
*D. gundensis**	–	–	–	+	+	–	–	–
*D. agumbensis**	–	+	+	–	–	–	–	–
D. nagarholensis	–	–	–	–	–	+	–	–
Species *'U'****	–	–	–	–	+	–	–	–
Species *'N'****	–	–	–	–	+	–	–	–
D. nasuta	+	+	+	+	+	+	+	+
D. neonasuta	+	+	+	+	+	+	–	–
D. immigrans	–	–	–	+	+	–	+	+
D. brindavani	+	–	–	–	+	–	–	–
D. repleta	–	–	–	–	–	+	–	+
D. nigra	–	–	–	+	–	–	+	–
*D. grandis***	–	–	+	–	–	–	–	–
D. meijerei indicus	–	–	–	–	+	+	–	–
D. mundagenesis	–	–	+	–	+	+	–	–
D. krishnamurthyi	+	–	–	–	–	–	–	–
D. busckii	+	–	–	–	–	–	–	+

TABLE 10 (*Contd.*)

Localities	Khandala Ghats	Sahyadri Hills' range	Agumbe	Jagra Valley	Bababudangiri & Kemmangundi Hills' range	Nagarhole	Kotagiri	Anamalai Hills' range
Genus: *Scaptomyza*								
*S. elmoi***	–	–	–	–	+	–	–	–
Genus: *Leucophenga*								
L. interrupta	–	–	–	–	–	–	–	+
Genus: *Phorticella*								
*P. flavipennis***	–	–	–	–	–	–	+	–

+ Species present; – Species absent; * New species; ** New reports;
*** Unidentified members of the genus *Drosophila*.

bers of this genus in different geographical regions of the earth will enable one to understand the principles underlying adaptive radiation and certain mechanisms involved in speciation. Reference to literature reveals that *Drosophila* species are not evenly distributed in nature. The occurrence and the distributional pattern can be correlated not only with the type of vegetation and climatic conditions of the area under consideration but also with the colonizing abilities of the species concerned.

The eight localities of Western Ghats from which *Drosophila* samples were analysed exhibit similarity in the habitats with more or less uniform macro-environmental factors such as temperature, humidity, rainfall, vegetation, availability of food, etc. Inspite of this, the localities differ from one another with regard to the species composition and the number of individuals of different species. Further significant variation in the number of individuals of different species was observed amongst the sites chosen under study. These observed differences in the faunal constellation of *Drosophila* species among the sites of any one locality and between the different localities may be accounted for by the differences in the micro-environmental factors.

Reddy and Krishnamurthy (1974), Siddaveere Gowda *et al.* (1977) have pointed out that even though several species could be collected in the orchards, gardens, plantations and some forested areas of Peninsular India, only four species namely *D. malerkotliana, D. nasuta, D. rajasekari* and *D. brindavani* were found to be dominant and more or less widely distributed. But the present study on the *Drosophila* fauna of tropical rain forests of Western Ghats revealed a different picture in the composition of the species. For instance, only two species — *D. malerkotliana* and *D. nasuta* were found to be distributed throughout the range of Western Ghats dominating other species in the collections. While the other two species, *D. rajasekari* and *D. brindavani* were shown to be present in only one or two localities indicating their lack of competence to colonize in the tropical rain forests. Therefore, based on the distribution and the dominance of the species in the natural habitats of the Peninsula only two species, *D. malerkotliana* and *D. nasuta* can be adjudged as generalist species. Their wide-

spread occurrence and dominance over others in the area under investigation can be correlated with their ecological versatility to exploit diverse habitats. Interestingly, *D. immigrans* which was not reported from the semi-wild and domestic localities of Peninsular India was observed in large numbers in four of the eight localities of Western Ghats indicating its preference to the moist and humid climatic conditions. Further, nine species namely *D. takahashii, D. bipectinata, D. pseudoananassae, D. mysorensis, D. jambulina, D. montium, D. neonasuta, D. nigra* and *D. meijerei indicus* which were occasionally reported in the plains of Peninsula were found to occur more or less frequently in the tropical rain forests indicating the availability of favourable breeding sites for their colonization. The domestic species such as *D. melanogaster, D. ananassae* and *D. repleta* which occur mainly in and around human habitations obviously as expected were absent in the tropical rain forests except for a few individuals of *D. ananassae* and *D. repleta* at some sites indicating their inability to colonize in the tropical rain forests where other species dominate. The most noteworthy feature of the Drosophilid fauna of the area under investigation is the occurrence of many species such as *D. suzukii, D. eugracilis, D. anomelani, D. punjabiensis, D. kikkawai, D. rufa. D. seguyi, D. mundagensis, D. krishnamurthyi* and *L. interrupta* which were not reported from the plains of Peninsula In additions the collection data revealed the occurrence of six new species namely *D. giriensis* (Prakash and Reddy, 1977), *D. jagri* (Prakash and Reddy, 1979), *D. sahyadrii* (Prakash and Reddy, 1979), *D. agumbensis* (Prakash and Reddy, 1978), *D. nagarholensis* (Prakash and Reddy, 1980) and *D. gundensis* (Prakash and Reddy, 1977). Similarly five species, *D. elegans, D. rhopaloa, D. grandis, S. elmoi* and *P. flavipennis* found in the collections are new records from the sub-continent. In view of this, the Drosophilid fauna of Western Ghats is of special interest and value as it offers a rich abode for a variety of species. Moreover, it is clear from the data that the species diversity in the tropical rain forests of Western Ghats is exceedingly more complex than that of other habitats of the Peninsula, thus indicating the dependance of *Drosophila* species upon the types of vegetation. Therefore, we are of the opinion that the complex natural habitats with diverse plant species provide large number of breeding sites for the colonization by diverse species of *Drosophila.* The tropical rain forests of Western Ghats are considered to have played a unique role in the adaptive radiation and paved the way for extensive speciation in the members of the genus *Drosophila.* This does not, of course, necessarily mean that no new or rare species will be found in the habitats other than moist deciduous and evergreen forests. But the probability of such discovery must be regarded as low. Further, intensive collections of *Drosophila* species from this area are needed to decide, if indeed any species is restricted to one or few sites, and if so, what special ecological niche is being exploited.

A great majority of the species are endemic to particular geographical areas of the earth. Thus it is apparent that each of the six continental regions (Darlington 1957) appears to have their own characteristic constellation of indigenous species. According to Stone *et al.* 1960, the endemism may amount to 95% of the known species of the genus *Drosophila.* Carson (1965), recognized three distinct groups based on the pattern of distribution of various members of the genus *Drosophila.* They are, 1. species having restricted distribution (endemism of Patterson and Stone 1952),

2. virtually cosmopolitan species and 3. species having a tendency to spread widely but not cosmopolitan. Only eight species, *D. melanogaster, D. simulans, D. ananassae, D. hydei, D. repleta, D. busckii, D. immigrans* and *D. funebris* are listed in the second category. In addition to cosmopolitan species, a number of species may be recognized which have some tendency to spread geographically but still have not become world-wide. Nine of the species listed in this category are *D. latifascisformis, D. pseudoobscura, D. kikkawai, D. nebulosa, D. willistoni, D. virilis, D. buzzatii, D. mercatorum* and *D. nasuta.* However, this category should not be taken as a precise one as it serves only to focus attention on certain species which have characteristics that place them in a roughly intermediate position between the endemic species on one hand and the cosmopolitan species on the other.

Of the 37 *Drosophila* species recorded in the present study 13 species of which, six are new, namely, *D. giriensis, D. jagri, D. sahyadrii, D. agumbensis, D. nagarholensis* and *D. gundensis* were described by us; and seven others namely *D. anomelani, D. mysorensis, D. neonasuta, D. brindavani, D. meijerei indicus, D. mundagenesis* and *D. krishnamurthyi* have been considered as endemic to India, since they are not reported elsewhere.

With regard to the second category of Carson 1965, only four of the eight cosmopolitan species namely, *D. ananassae, D. immigrans, D. repleta* and *D. busckii* were observed in the present study. However, *D. melanogaster,* another cosmopolitan species, which can be trapped from almost all the human habitated localities of Peninsular India was found to be absent in the collections. The absence of *D. melanogaster* and three other cosmopolitan species, *D. simulans, D. hydei* and *D. funebris* from the collections is a noteworthy feature and corroborates with the earlier studies on the *Drosophila* species inhabiting the forested areas of the sub-continent (Gupta 1974, Reddy and Krishnamurthy 1974). Therefore, the present investigation indicates that the cosmopolitan species which have been recorded mainly from human habitations have hardly been found to be invaded into an otherwise unsuitable niche. It is presumed that the resources are fully utilised by other ecologically versatile species thus preventing the colonization of the cosmopolitan species in these habitats. Several authors (cf. Watts 1971) have recorded that closed forest communities rarely receive invading plants, since competition for niches may be severe. Because of the dependance of *Drosophila* on plants as a resource, the lack of success of cosmopolites is to be expected in the rain forests (Bock and Parsons 1977). Thus, the present finding is in support of the statement of Dobzhansky (1965) who viewed that none of the cosmopolitan species are truely so, but have reached the quasi-cosmopolitan status with man's aid.

Of the nine species listed in the third category only two species *D. kikkawai* and *D. nasuta* were noticed in the present collections. However, other species such as *D. takahashii, D. suzukii, D. rajasekari, D. elegans, D. eugracilis, D. pseudoananassae, D. malerkotliana, D. bipectinata, D. punjabiensis, D. jambulina, D. montium, D. rufa, D. seguyi, D. rhopaloa, D. nigra* and *D. grandis* found in the collections may also be assigned to the intermediate position as judged by their occurrence in other parts of the world.

Brncic (1970), has categorised the *Drosophila* species into two groups namely widespread and endemic species. According to him the widespread or endemic character of

a species in the absence of geographical barriers is a function of the abundance and distribution of the ecological resources that the species may utilize. The existence of endemism may be an expression of the ecological restriction. For instance, the endemic species that have been referred to in the present investigation appear to be closely related to the tropical moist deciduous and evergreen forests of Western Ghats except for *D. mysorensis, D. neonasuta* and *D. brindavani* which were reported to be present in other habitats of the Peninsula. Similarly, the wide distribution of a species does not always need to be related to the ecological versatility. Probably this is the case for some of the domestic cosmopolitan species which are adjusted to some human made habitats. Majority of the species collected from the Western Ghats have also been reported from other parts of the world indicating their wide spread nature. The reason for the widespread occurrence of these species could be correlated with the ecological versatility enabling them to live and reproduce in many different environments.

The most interesting feature of the collection data is that, although many species could be collected at any particular locality, members of the *melanogaster* and *immigrans* species groups belonging to two subgenera *Sophophora* and *Drosophila* comprise all or practically all of the catch indicating the sympatric association and ecological dominance of the members belonging to these two species groups. However, certain other species such as *D. repleta, D. nigra, D. grandis, D. meijerei indicus, D. mundagenesis, D. krishnamurthyi* and *D. busckii* belonging to other subgenera were also found occasionally in the collection. Further, it is clear from the present study that the members of the *melanogaster* species group in particular were found to be more versatile as evidanced by the variety of species. Thus the ecological dominance of the members of the *melanogaster* and *immigrans* species groups observed is in conformity with the earlier reports on the South Indian *Drosophila* fauna (Reddy and Krishnamurthy 1974, 1977 and Siddaveere Gowda *et al.* 1977) and also with the suggestion of (Bock and Wheeler 1972), who regarded the Indian subcontinent as the general area for the origin of *melanogaster* species group, and South-East Asia in general, for the origin and wide speciation for both *melanogaster* and *immigrans* species groups. Incidentally the finding of six new species and two new records of species belonging to *melanogaster* species group from this area further supports the suggestion of Bock and Wheeler (1972). Based on our collection data, it is obvious that the suggested dominance of the members of the two species groups belonging to two different subgenera of the genus *Drosophila* in a substantial area of the world is in itself a unique phenomenon. With more intensive collections of *Drosophila* in Western Ghats, it is possible to understand many problems concerning the origin and evolution as well as the distribution and ecological relationships of the members of these two subgenera.

Subramanyam and Nayar (1974) have pointed out that the Western Ghats behave like an oceanic island in the development of endemic species of plants as it is protected by sea on Western side, Vindhya and Satpura on northern side and semiarid Deccan plateau on eastern side. Similarly the present investigation has revealed the occurrence of 13 endemic species, of which six species namely *D. giriensis, D. jagri, D. sahyadrii, D. agumbensis, D. nagarholensis* and *D. gundensis* are new. In addition, five Drosophilid species namely *D. elegans, D. rhopaloa, D. grandis, S. elmoi*